## Space Weather Technical Forecast

Issued on Tuesday 4 February 2025 at 13:06 Local

**This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Chance of a glancing blow from a CME day 3 (06 Feb). Further M-class flares expected, slight chance of an X-class flare.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity was moderate over the past 24 hours, with frequent M-class flares, most of which originated from AR3981. The strongest recorded was an M6.1 flare, peaking at 03/1318 UTC.

There are eight active regions on the Earth-facing disc. The majority of the activity is from the broad cluster of sunspots in the north spanning the central disc, consisting of AR3976, AR3977, AR3978, AR3981 and AR3982. These form a rather large and complex area of multiple bipolar active regions, with signs of magnetic interaction between the regions suggesting the ongoing potential for notable flares. AR3976, AR3977 and AR3978 continue to slowly evolve, mostly showing recent slight growth. AR3981 meanwhile continues to increase in overall areal extent, and has two delta configurations within its intermediate and trailer spots. This region continues to produce the majority of the flare activity.

An M4.1 flare from AR3981 at 02/2324 UTC was followed by a faint CME from the southeast in imagery. This has been analysed to potentially give a glancing blow at Earth on 06/0700UTC, although this is low confidence.

**Solar Wind / Geomagnetic Activity:** Solar winds as measured by ACE at L1 showed a declining connection to CH11/+, with speeds falling from an average of 460 km/s to 420 km/s. Density was below average. The Interplanetary Magnetic Field, Bt, was initially moderate, peaking at around 11nT, but steadily decreased to current weak levels. The north-south component, Bz, was largely weakly positive. Phi angle was mainly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

**Energetic Particles / Solar Radiation:** High energy proton flux at GOES18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background to moderate levels, peaking at 227 pfu. The associated 24-hour fluence persisted below the Active threshold, recording 6.37e6 integrated pfu at 04/0000UTC.

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**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Generally Moderate activity is forecast, with M-class flares expected at times and a slight chance of isolated X-class flares, primarily from the regions in the north spanning centre disc.

**Solar Wind / Geomagnetic Activity:** A CME associated with an M4.1 flare late on 02 Feb may give a glancing blow with Earth on the morning of day 3 (06 Feb), although this is low confidence. The potential for further CMEs is elevated. Earth is still connected to CH11/+, but with wind speeds continuing to decline, likely returning to background levels by day 2 (05 Feb). Solar winds may return to slightly elevated or elevated levels for a time on day 3 (06 Feb), following any potential CME arrival.

Generally Quiet to Unsettled (Kp 1-3) geomagnetic activity is expected as Earth continues to come out of the coronal hole high speed stream. Following any potential CME arrival on day 3, there is a chance of seeing activity temporarily increase to give a chance of G1-G2/Minor-Moderate Geomagnetic Storm intervals (Kp 5-6).

**Energetic Particles / Solar Radiation:** GOES18 high energy proton flux is likely to be at background levels, but with a slightly increasing potential of responding to any notable flares as the sunspot regions in the north move into the western hemisphere. High energy electron flux observed at GOES16 has recently remained at Moderate levels. This is expected to persist, with a chance of becoming briefly diurnally High. The corresponding 24 hour fluence is expected to persist below the Active threshold.

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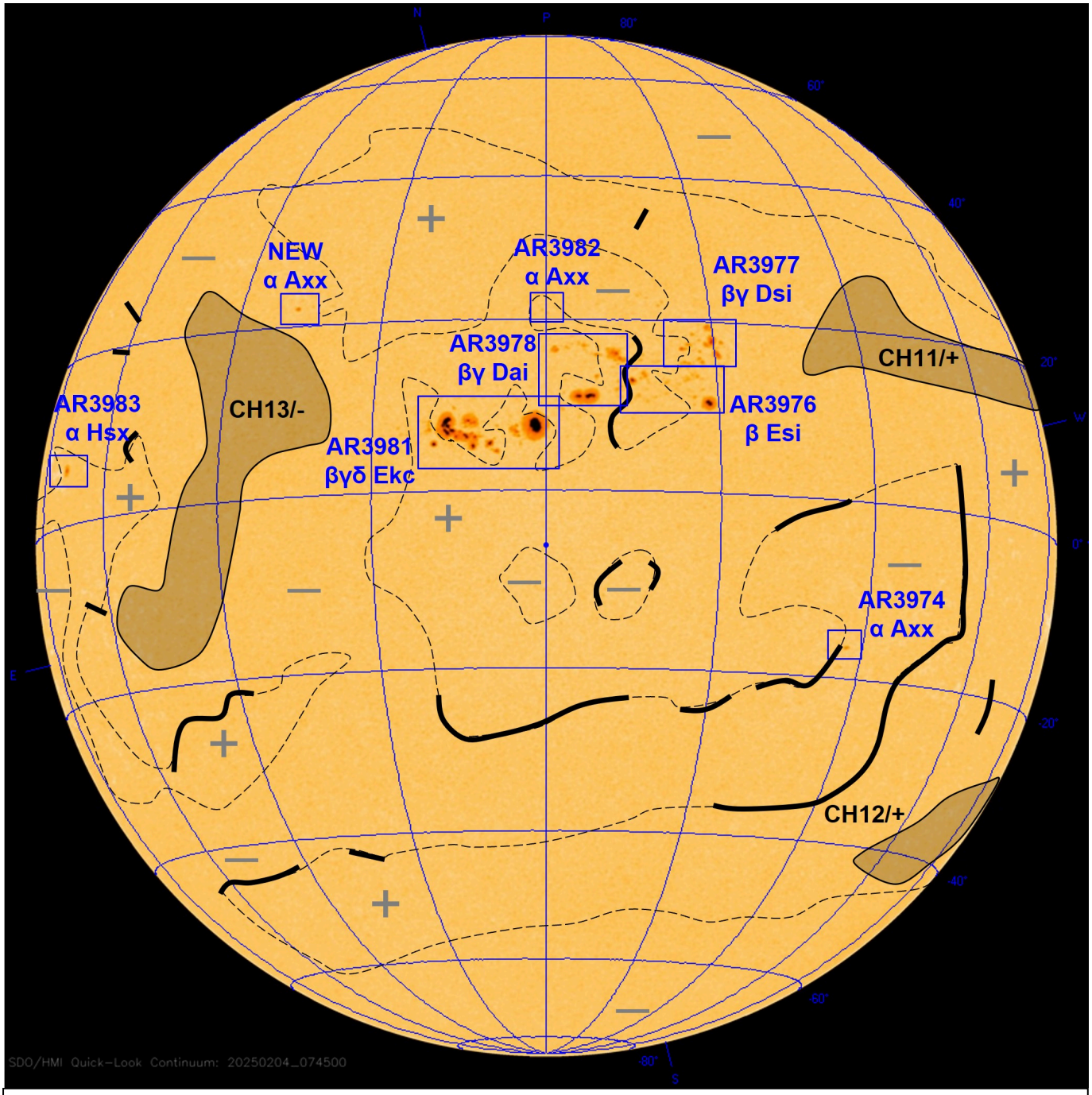
**Figure 1: Solar synoptic map valid 04/0745UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms

One CME currently features in the forecast, a faint CME associated with an M4.1 flare at 02/2320 UTC from AR3981. This CME was faint and occurred at a similar time as a larger, far-sided CME, which lowers the confidence of analysis. However there is a possibility the CME could make a glancing impact with Earth on the morning of day 3 (06 Feb). The potential for further CMEs also remains elevated, with a number of large filaments in potentially geoeffective positions and the large cluster of the sunspots to the north currently rotating through centre-disc.

Earth is still connected to CH11/+ but with wind speeds continuing to decline, currently around 430km/s. Solar wind speeds are expected to gradually ease during day 1 (04 Feb), likely returning to generally background levels by day 2 (05 Feb). MOSWOC ENLILs gradual decline is accepted, with solar wind speeds considered well modelled. Solar winds may return to slightly elevated or elevated levels for a time on day 3 (06 Feb), following any potential CME arrival. The high speed stream of CH13/- is expected to arrive at Earth beyond this forecast period.

Generally Quiet to Unsettled (Kp 1-3) geomagnetic activity is expected as Earth continues to come out of the coronal hole high speed stream. Following any potential CME arrival on day 3, there is a chance of seeing activity temporarily increase to give a chance of G1-G2/Minor-Moderate Geomagnetic Storm intervals (Kp 5-6).

| Geomagnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 5 | 10 | 40 | 20 |
| Strong | G3 | No | 1 | 1 | 5 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

**Geomagnetic Activity - Earthbound Coronal Mass Ejections**

| Date/time 21.5R⊙ (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed (km/s) | Estimated Arrival Time (UTC) | Comments |
|---|---|---|---|---|---|---|
| 03/0457 | Partial | AR3981 | NE | 590 | 06/0700 +/- 6 hours | Chance of glancing impact, but low confidence. |

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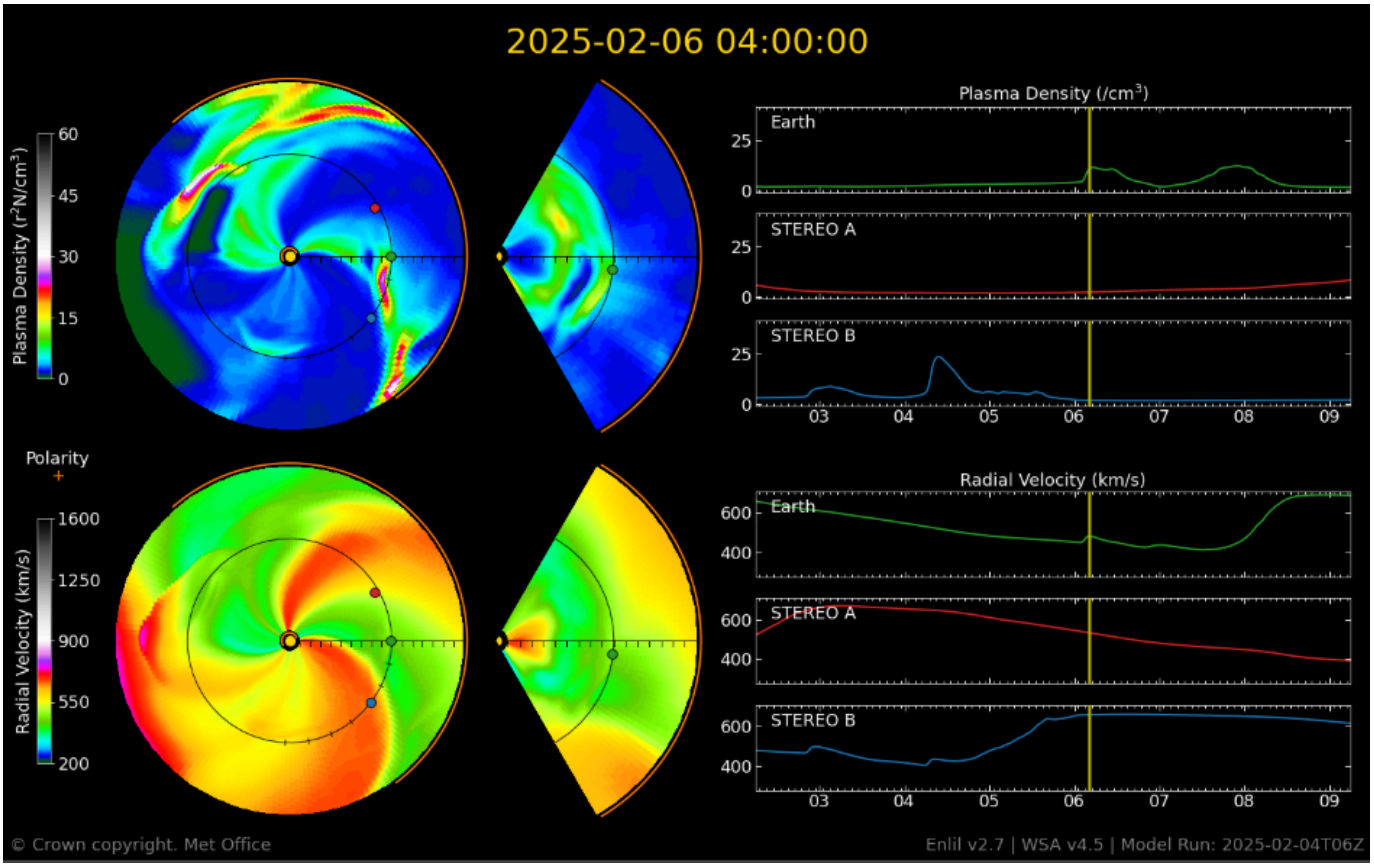
**Figure 2: MOSWOC ENLIL**



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## Radio Blackouts - X-Ray Flares

Solar activity was moderate over the past 24 hours, with frequent M-class flares, most of which originated from AR3981. The strongest recorded was an M6.1 flare, peaking at 03/1318 UTC.

There are eight active regions on the Earth-facing disc. The majority of the activity is from the broad cluster of sunspots in the north spanning the central disc, consisting of AR3976, AR3977, AR3978, AR3981 and AR3982. These form a rather large and complex area of multiple bipolar active regions, with signs of magnetic interaction between the regions suggesting the ongoing potential for notable flares. AR3976, AR3977 and AR3978 continue to slowly evolve, mostly showing recent slight growth. AR3981 meanwhile continues to increase in overall areal extent, and has two delta configurations within its intermediate and trailer spots. This region continues to produce the majority of the flare activity, including the largest M-class flare of the period. The remaining spots, are small and simple.

Further M-class flares are anticipated, primarily from AR3981 or a nearby region, with a slight chance of an X-class flare.

No significant regions are due to rotate off the disc in the forecast period. Recurrence suggests the potential for returning regions during the period, although far-side helioseismic output has no strong signals in the short term.

| X-Ray Flares Probability | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **R1-R2 (M Class)** | Yes | 80 | 80 | 80 | 80 |
| **Very Active** | **R3-R5 (X Class)** | No | 20 | 20 | 20 | 20 |

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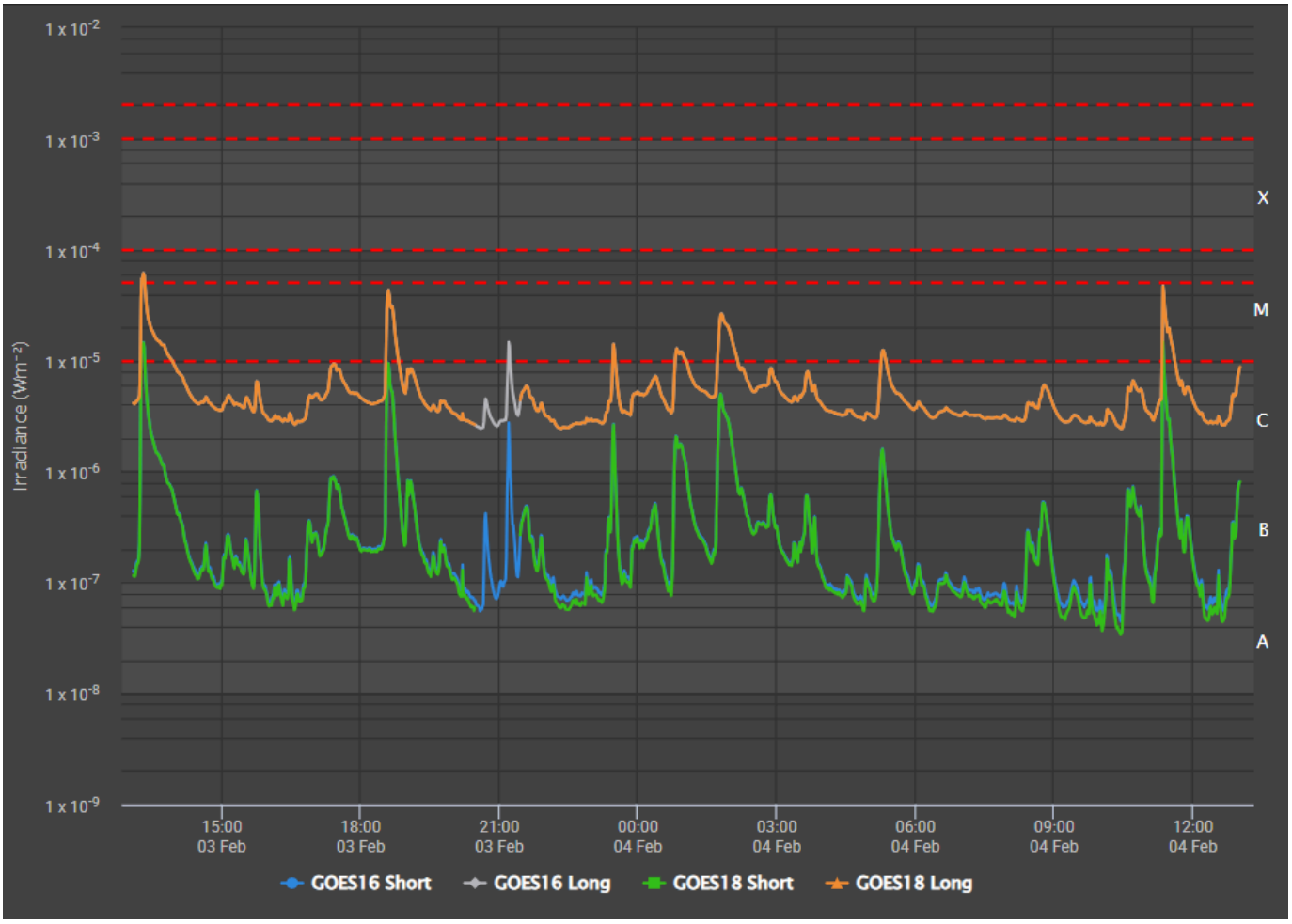
**Figure 3: 24 hour X-Ray trace.**



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## Solar Radiation Storms (High Energy Protons)

Proton flux as observed by GOES-18 is currently at background levels, and is generally likely to remain that way, at least at first. As the large cluster of sunspots in the north move from centre-disc into the western hemisphere, there is a gradually increasing chance of proton flux rising in response to any notable flares.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}sr^{-1}s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 20 | 20 | 25 | 30 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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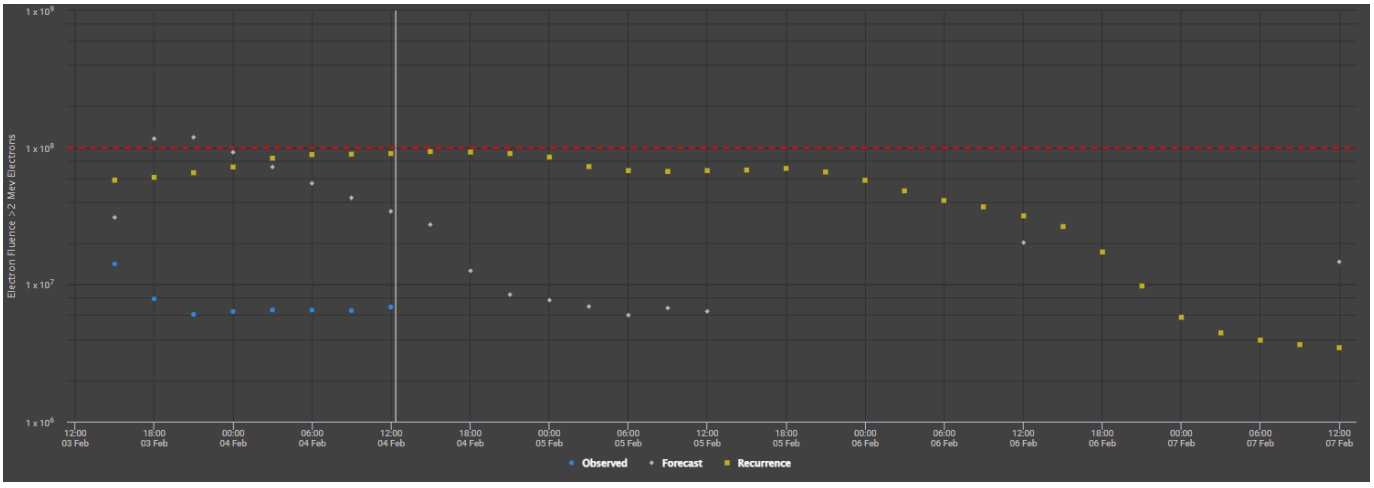
## High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has recently remained at Moderate levels. Given the lack of geomagnetic activity recently, the Van Allen belts are unlikely to be sufficiently charged to bring a dramatic increase in flux in coming days, with a chance of becoming briefly diurnally High.

The corresponding 24 hour fluence is expected to persist below the Active threshold. MOSWOC REFM output is currently thought to be providing reasonable guidance.

| GEO Electron Environment | Level ($cm^{-2}sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1\times10^{8}$ | No | 5 | 10 | 10 | 5 |
| Very Active | ≥ 2 MeV ≥ $1\times10^{9}$ | No | 1 | 1 | 1 | 1 |

**Figure 4: MOSWOC REFM integrated flux/fluence forecast, recurrence and observations.**

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